OBSERVATIONS ON THE BIOLOGY OF AMPHIZOIDAE

By J. Gordon Edwards[1]

During the summer of 1953, while employed as a ranger-naturalist in Glacier National Park, Montana, the author continued his investigations into the biology of members of genus *Amphizoa* (family Amphizoidae). Several new observations resulting from this work are here published.

Amphizoa is the sole genus of the family and is represented by only five known species, two of which occur in Glacier National Park. The genus occurs in North America from Colorado to southern California and to Alaska, and another species is known from Tibet. The species found in Glacier National Park are *A. insolens* Leconte and *A. lecontei* Matthews, both being commonly represented in streams at elevations of 3,000 to 4,000 feet in this area. They coinhabit the same streams and are often found together on the same piece of drift-wood, yet the species are very distinct, their members differing in the external morphology of adults and larva as well as male and female genital appendages. It is indeed unusual to find two distinct species of a single rare genus so closely associated in habitat and geographic range, with their members competing for a single source of food.

The adult beetles are dark brown or black, about 12 mm long (*A. insolens*) to 14 mm long (*A. lecontei*), and live submerged beneath the icy waters of mountain streams, being most abundant on driftwood floating in frothy eddies, or along the banks of the stream where grass roots of the undercut banks drag in the water. (In the Olympic Peninsula of Washington a favored habitat is in masses of submerged pine needles where they accumulate among the small rocks along the shore of quiet stretches of streams such as the Soleduc River.) These beetles are highly regarded as collectors' items, yet most western Coleopterists could probably find them in this type of habitat during the summer, if they would search carefully for them.

EGGS

Amphizoa eggs never have been recorded prior to this report. The nearest relatives of *Amphizoa* belong in genus *Pelobius*. Their first larval stage is said to be truly aquatic, resembling the nauplius stage of some aquatic Crustacea and possessing gills, hence they look quite unlike the later stages. It was impossible to say what the first larval stage of *Amphizoa* would look like until eggs were discovered and the emerging larvae observed. Last winter Mr. Harry P. Chandler, of Red Bluff

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California, gave the writer some larvae of *Amphizoa insolens* which measured only 4.5 to 5 mm in length. These larvae seemed too large to have hatched very recently from eggs of beetles which are only 12 mm long as adults, hence there was still considerable speculation about the possibility of finding a nauplius-like first instar larval stage of these insects. Considerable time was spent searching for eggs or smaller larvae early last summer. Near the end of August larvae as small as those collected by Mr. Chandler became suddenly abundant, but none were any smaller than that. At last, however, a piece of floating wood in a quiet eddy was examined and found to be adorned with nine large insect eggs which were elliptical and were fastened loosely into small cracks on the under-surface of the weathered drift-wood. Each egg was about 2.1 mm long and 1 mm in diameter. Close examination revealed six dark ocelli showing through each side of some of the eggs, and these ocelli were spaced exactly like those of the young *Amphizoa* larvae. In hopes that they would hatch, the eggs were kept in a tumbler of water for several days, with the water changed frequently to keep it cold and well aerated. No changes were seen during that time, so two of the eggs were carefully teased open and the premature larvae were removed. They were *Amphizoa* and were identical in structure with the small ones already collected but were still completely white, except for the darker ocelli. They were tightly tucked up in the eggs, but when straightened out each measured over 3.5 mm long. Both were lifeless, so the remainder were preserved as eggs in alcohol. These observations cleared up the mysteries about the nature of the egg and the first larval stage of these fascinating beetles, all in a single interesting week.

LARVAE

During the month of July *Amphizoa* larvae were quite abundant in Swiftcurrent Creek, and considerable time was devoted to their study. In the revisional study of family Amphizoidae[2] is was stated that the larvae when dislodged float helplessly, seeming to be unable to swim effectively. In view of their sluggishness, it was suggested that they probably feed upon dead insects and other small bits of organic material which are washed into their immediate surroundings. Larvae of various sizes were placed in glass tumblers and kept under observation for periods of a week or more each. In each tumbler containing an *Amphizoa* specimen a short twig was placed so that it rested in one corner of the container and extended out of the water, leaning against the dry side of the upper portion of the glass. The adults normally remained

entirely submerged, but the full-grown larvae invariably crawled up the twig until their bodies were entirely out of the water. During their imprisonment they were offered a variety of foods, including many types of dead animals and several kinds of living creatures. All larval stages displayed alacrity in grabbing Plecoptera (stonefly) naiads, or nymphs, which were introduced into their containers, but never showed any interest in dead insects or in insects other than stoneflies. Adults were subsequently found to share these tastes, and on one occasion a full-grown larva competed with an adult *Amphizoa* for a Plecoptera naiad. They soon chewed it into pieces, after which each individual ate the part it had retained. Naiads usually died in a few minutes after being placed in the unoxygenated water of the tumbler, after which neither the adults or larvae of the beetles displayed any interest in them. To summarize, it may now be stated that both larvae and adults of the genus are predaceous, and that they seem to restrict their diet to the immature stages of Plecoptera (stoneflies).

Upon studying the young larvae closely, in their natural surroundings, it was discovered that when dislodged they assume a characteristic position, while floating in relatively quiet water. This position is one which: (1) enables them to respire while afloat, through the enlarged spiracles situated on prominences of the eighth abdominal tergite; (2) to quickly capture prey in their powerful jaws if any victim comes within reach; and (3) to immediately grasp (with their legs) any solid object they touch. The position which affords all of these advantages is one with the abdomen in the normal horizontal position (spiracles of the eighth abdominal tergite located at the surface of the water) and with the thorax and head tucked under the abdomen so that the mandibles lie beneath the abdominal tip. The young larvae were especially quick to assume this position when afloat, and older specimens also showed a distinct tendency toward this behavior.

As mentioned earlier, the larvae in captivity always crawled up the wooden twig or onto a floating piece of wood until entirely out of the water (but near it) and there they might stay for days. If a live stonefly naiad were placed in the water the larva would quickly enter the water, capture it as it swam past, and retire to the twig to eat the victim. The naiads were usually grasped near the middle of the dorsum and eaten while the larva clung to the twig, head upward. As the mandibles worked from side to side each chewing movement would usually tuck a

[2]Edwards, J. G. 1950 (1951). "Amphizoidae of the World," Wasmann Jour. Biol. 8:303-332, 4 plates.

little more of the prey into the larva's mouth, until finally only the head and tail remained visible, then they too disappeared.

PUPAE

Full grown larvae were seen leaving the water of the stream in late July and early August and crawling up the muddy banks until several inches from the water's edge. Several were watched until they hid under rocks or small pieces of wood, but unfortunately their ultimate goal was never ascertained. Perhaps they pupate underground or in the masses of debris which are deposited along the stream-bank during the high spring waters, or perhaps they overwinter as large larvae and pupate the following spring. At any rate, the pupae of these beetles are as yet unknown to entomologists. Mr. Harry P. Chandler reports (in personal correspondence) that he found two full-grown *Amphizoa* larvae at the north fork of the Fresno River (4,000 ft. elevation) in Madera County, California, on June 21st, 1953, under conditions which probably would soon have led to pupation. The fully-extended larvae were enclosed in protective cases which were lodged in debris-filled crevices between logs, one at a distance of about 1½ feet above the water and the other about 4 feet above the water level and 2 feet back from the edge of the stream. Thinking that they must be nearly ready to pupate, he carried them home to Red Bluff, California, to try to rear them to adult-hood, but the heat in the San Joaquin and Sacramento valleys killed them both en route. Nobody really knows how long the larvae normally live, how long the entire life cycle requires, or anything concerning the longevity of adults of this family. The author's collection data would lead to the assumption that the first or second instar larvae overwinter and then become full-grown early the following spring. Adults are most abundant in middle and late August, and oviposition takes place near the end of that month. More complete data will be sought next summer concerning these matters.

ADULTS

Respiration of adults: *Amphizoa* adults, like all beetles, lack gills and cannot respire unless air is frequently in contact with their spiracles. It was previously believed that they would drown unless they stayed near the surface of the water, so they could thrust the large spiracles of their eighth abdominal tergite into the air occasionally. Consequently, it was interesting to observe them surfacing briefly, then carrying down a large air bubble at the tip of their body when they submerged. The air bubble surrounded the tips of the elytra but was mostly held

beneath the elytral apices. Accurate timing was not attempted, but these insects can certainly remain submerged for at least ten minutes, and probably many times that long. There may be an interchange of gases between the air enclosed in the bubble and the surrounding water, through the wall of the submerged bubble (with the CO_2 in the bubble being altered to O_2) so that there should be almost no limit to the length of time the beetles could remain submerged. Definite timing records are planned for next summer to determine how often these beetles come to the surface for fresh air bubbles.

Feeding habits of adults: It has often been suggested in the past that these beetles were scavengers, due to their selection of habitats where dead insect bodies frequently float nearby. This belief was definitely found to be fallacious last summer in Montana. The writer captured many *Amphizoa* adults and kept them in glass tumblers, under observation. Many kinds of food were introduced into the tumblers in an effort to discover what the beetles preferred. Never did any specimen make a move toward non-living insect specimens, even when the dead organisms were agitated with a straw or a thread. They quickly captured living stonefly naiads, however, usually after the victims had made only one or two circuits of the inside of the tumbler. The beetles displayed amazing speed in capturing these agile nymphs, grasping them in their stout mandibles, then moving back to the support of the twig in each glass tumbler. They then clung to the twig and began to chew on the naiad. Their original grip was usually at about the middle of the victim's back, and as they chewed on their prey they pulled a little more of it into their mouth with each closure of the jaws, just as the larvae of this genus do. The head and tail of the victim were normally the last parts to enter the mouth. Occasionally a naiad would be chewed in half, after which the beetle would usually allow the two halves to sink to the bottom of the glass and would ignore them from then on. Thus it seems that the adults of *Amphizoa* (as well as the larvae) are predators, never scavengers, and that they prefer the naiads of Plecoptera to any other prey offered them during these observations. Evidently they frequent their preferred habitats because those ecological niches are shared by many Plecoptera naiads, upon which the beetles feed greedily.

CONCLUSIONS

The study of the biology of *Amphizoa* beetles is still very incomplete. It is hoped that next summer's work in Glacier National Park will reveal the answers to some of the perplexing problems listed below:

1. What kinds of food are acceptable and/or preferred by adults and larvae of *Amphizoa?*
2. Do some of the early-instar larvae overwinter? If so, where do they hide?
3. Where do the full-grown larvae go after they leave the water, and how do they behave?
4. What type of secretion do they use in cementing together the protective case in which they may pupate?
5. Where is the pupal stage passed, how long does it last, and what does it look like?
6. How long does each life stage require, and what is the longevity of adults?
7. How long can *Amphizoa* adults remain submerged without suffocating?
8. How long can *Amphizoa* larvae remain submerged without suffocating?
9. What morphological and biological characteristics may be used to separate the larvae of our four species of *Amphizoa* in the United States?

All information from readers of the Coleopterists' Bulletin, concerning these beetles and their larvae, will be gratefully acknowledged by the author in future notes dealing with them.

A NEW RECORD OF EPICAUTA STUARTI

Epicauta stuarti LeC. is an unusual, rather rare species with a strong superficial resemblance to *Tetraonyx quadrimaculata* (Fabr.). Dillon (Amer. Midland Nat., 48:416, 1952) considered *stuarti* distinct enough to propose a new genus, *Maculicauta,* for it. It has been reported from the Texas panhandle, eastern New Mexico, eastern Colorado, and Kansas. No host plants are recorded for it.

On September 10, 1953, in a prairie pasture 3 miles west of Chappell, Nebraska, near the northeastern corner of Colorado, five specimens of *stuarti* were collected on a composite, *Gutierrezia sarothrae* (Pursh). The beetles were feeding on pollen, in association with two other species of *Epicauta, callosa* LeC. and *pennsylvanica* (DeG.), and an extremely abundant cantharid, *Chauliognathus limbicollis* LeC. The general color pattern of *stuarti* is so similar to that of the *Chauliognathus* that it was easy to confuse the two without close inspection when individuals were crawling through the bushy host plant. The resemblance here is striking enough to warrant the hypothesis that the color pattern in *stuarti,* so unique for the genus *Epicauta,* is the result of mimicry.

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